## Claims

[c1] A method of depositing a dense, strain-tolerant, vertically-cracked YSZ-containing ceramic layer on a second ceramic layer present on a substrate, the second ceramic layer having a composition containing either a combination of YSZ and mullite or a combination of YSZ and an alkaline-earth metal aluminosilicate, the method comprising the step of depositing the YSZ-containing ceramic layer using a plasma spraying technique while maintaining the substrate at a temperature of not greater than 600 ° C if the composition of the second ceramic layer contains the combination of YSZ and mullite, and a temperature of not greater than 500 ° C if the composition of the second ceramic layer contains the combination of YSZ and alkaline-earth metal aluminosilicate.

[c2] A method according to claim 1, wherein the substrate is maintained at a temperature of at least about 300 ° C during the depositing step.

[c3] A method according to claim 1, wherein the YSZ-containing ceramic layer consists essentially of YSZ.

[c4] A method according to claim 3, wherein the second ceramic layer is a mixture consisting essentially of the YSZ and either mullite or an alkaline-earth metal aluminosilicate.

[c5] A method according to claim 1, wherein the composition of the second ceramic layer contains the combination of YSZ and mullite.

[c6] A method according to claim 5, wherein the second ceramic layer contains about 50 volume percent mullite and about 50 volume percent YSZ.

[c7] A method according to claim 5, wherein the substrate is maintained at a temperature of up to about 550 ° C during the depositing step.

[c8] A method according to claim 1, wherein the composition of the second ceramic layer contains the combination of YSZ and alkaline-earth metal aluminosilicate.

[c9] A method according to claim 8, wherein the second ceramic layer contains

about 50 volume percent BSAS and about 50 volume percent YSZ.

[c10] A method according to claim 8, wherein the substrate is maintained at a temperature of about 450 ° C during the depositing step.

[c11] A method according to claim 1, wherein the second ceramic layer has a substantially uniform composition.

[c12] A method according to claim 1, wherein the second ceramic layer comprises sublayers, an innermost sublayer of the sublayers having a substantially uniform composition of either mullite or alkaline-earth metal aluminosilicate, an outermost sublayer of the sublayers contacting the YSZ-containing ceramic layer and having a substantially uniform composition of YSZ.

[c13] A method according to claim 1, wherein the second ceramic layer is compositionally graded, consists essentially of either mullite or alkaline-earth metal aluminosilicate at an innnermost region of the second ceramic layer nearest the substrate, and consisting essentially of YSZ at an outermost region of the second ceramic layer contacting the YSZ-containing ceramic layer, the second ceramic layer having a decreasing concentration of mullite or alkaline-earth metal aluminosilicate and an increasing concentration of YSZ in a direction toward the YSZ-containing ceramic layer.

[c14] A method of forming a thermal/environmental barrier coating system on a substrate formed of a silicon-containing material, the method comprising the steps of:

depositing a silicon-containing bond coat on the substrate;

depositing a mullite-containing first layer on the bond coat;

depositing a second layer on the first layer, the second layer consisting essentially of BSAS;

depositing a third layer on the second layer, the third layer consisting essentially of yttria-stabilized zirconia and either mullite or BSAS; and

depositing a dense, strain-tolerant, vertically-cracked topcoat of yttria-stabilized zirconia on the third layer using a plasma spraying technique while maintaining the substrate at a temperature of not greater than 600 ° C if the

third layer consists essentially of YSZ and mullite, and a temperature of not greater than 500 ° C if the third layer consists essentially of YSZ and BSAS.

[c15] A method according to claim 14, wherein the third layer consists essentially of YSZ and mullite, and the substrate is maintained at a temperature of about 300 ° C to about 550 ° C during the step of depositing the topcoat.

[c16] A method according to claim 15, wherein the third layer contains about 50 volume percent mullite and about 50 volume percent yttria-stabilized zirconia.

[c17] A method according to claim 14, wherein the third layer consists essentially of YSZ and BSAS, and the substrate is maintained at a temperature of about 300 ° C to about 450 ° C during the step of depositing the topcoat.

[c18] A method according to claim 17, wherein the third layer contains about 50 volume percent BSAS and about 50 volume percent yttria-stabilized zirconia.

[c19] A method according to claim 14, wherein the third layer has a substantially uniform composition.

[c20] A method according to claim 14, wherein the third layer comprises sublayers, an innermost sublayer of the sublayers having a substantially uniform composition of either mullite or BSAS, an outermost sublayer of the sublayers contacting the topcoat and having a substantially uniform composition of YSZ.

[c21] A method according to claim 14, wherein the third layer is compositionally graded, consists essentially of either mullite or BSAS at an innnermost region of the third layer nearest the substrate, and consisting essentially of YSZ at an outermost region of the third layer contacting the topcoat, the third layer having a decreasing concentration of mullite or BSAS and an increasing concentration of YSZ in a direction toward the topcoat.

[c22] A method according to claim 14, wherein the first layer is mullite or a mixture of mullite and BSAS.

[c23] A method according to claim 14, wherein the first layer consists essentially of mullite.

[c24] A method according to claim 14, wherein the substrate is formed of a material selected from the group consisting of metal matrix composites reinforced with silicon carbide, silicon nitride and/or silicon, composites having a matrix of silicon carbide, silicon nitride and/or silicon, and composites with a silicon carbide, silicon nitride and/or silicon matrix reinforced with silicon carbide, silicon nitride and/or silicon.

[c25] A method according to claim 14, wherein the substrate is a surface of a gas turbine engine component.